




Evolving Business Models for Renewable Energy

2014 Industry Review

American Council On Renewable Energy (ACORE)





EVOLVING BUSINESS MODELS FOR RENEWABLE ENERGY: 2014 INDUSTRY REVIEW

JUNE 2014

AMERICAN COUNCIL ON RENEWABLE ENERGY (ACORE)

ACORE, a 501(c)(3) non-profit membership organization, is dedicated to building a secure and prosperous America with clean, renewable energy. ACORE seeks to advance renewable energy through finance, policy, technology, and market development and is concentrating its member focus in 2014 on National Defense & Security, Power Generation & Infrastructure, and Transportation. Additional information is available at: www.acore.org

POWER GENERATION & INFRASTRUCTURE INITIATIVE

Power Generation & Infrastructure Initiative brings together leaders from the utility, business, investment, regulatory, public and non-profit sectors to: (1) examine the challenges, opportunities and appropriate strategies related to the expanded use and effective integration of renewable energy in the power generation sector; and (2) explore 21st century business models that will allow for this renewable energy scale-up. Additional information is available at: www.acore.org/programs/member-initiatives/power-generation

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Renewable energy continues to grow as a share of our nation's overall electricity portfolio, now responsible for 14% of total U.S. power generation. A combination of private sector ingenuity, investment and government policy certainty have driven significant cost reductions, technology improvements, and scale up of the renewable energy industry over the past several years. In 2013, nearly 40% of all new U.S. electricity generating capacity came from renewable energy.

At the same time, developments in natural gas extraction offer game-changing, but highly water-intensive opportunities; stringent environmental standards raise performance requirements; the central coal and nuclear generation fleet is rapidly aging, foretelling a very costly replacement scenario; and the transmission and distribution systems require expansion and upgrade. An updated policy framework and significant capital investment are required to modernize the power generation sector and assure reliable service. Technological innovations, regional differences in resource availability, the changing nature of customer relations and use patterns, emerging financing structures, the electrification of the transportation sector, and a murky policy certainty outlook present challenges and opportunities for this sector.

Building on the considerable progress power generation companies across the U.S. are making to integrate renewable energy, ACORE's Power Generation and Infrastructure Initiative brings together leaders from the utility, business and investment, regulatory, public, and non-profit sectors to define a viable architecture for the scale up and systems integration of renewable energy resources. The collaboration: (1) examines the challenges, opportunities and appropriate strategies related to the expanded use and effective integration of renewable energy in the power generation sector; and (2) explores 21st century business models that will allow for this renewable energy scale up.

PURPOSE OF THIS REPORT

This Industry Review explores key issues and provides recommendations related to the evolving power sector and increased use of renewable energy, particularly related to distributed generation and the effective integration of advanced grid technologies such as smart grids and microgrids. This report provides a series of industry perspectives with useful analysis, data, and insight for renewable energy and utility stakeholders, including:

- Insight into how distributed generation and advanced grid technologies are changing the power generation sector and traditional utility business models
- Suggested outcomes for the successful integration of renewable energy at scale
- Spotlights on how CSP and EVs are changing the way utilities look at generation, integration, and storage

A group of prominent renewable energy developers, professional service firms, energy service companies, and other groups authored the six articles in this Review.

The views and opinions expressed in this report are those of the authors and do not necessarily reflect the views of ACORE.

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Renewable Energy Drivers of Change and Overview of Actions from the Utility Perspective

Chris Vlahoplus, Cristin Lyons, and Paul Quinlan
Scott Madden, Inc.

Renewable generation resources, coupled with the innovation of enabling technology on the distribution grid, are creating the potential for disruptive change for electric utilities. While utility-scale renewable strategies can be similar to traditional utility-scale generation (i.e., large-scale assets with purchase power agreements (PPAs)), the utility business model may face significant changes from customer-sited distributed resources, especially distributed solar photovoltaics (PV).

Utilities' responses to distributed generation have varied, ranging from financing projects outside of the service territory to owning and operating distributed generation within the service territory. Regardless of direction, utilities are faced with the need to rethink how distributed resources affect their approach to: real-time operations; system planning; customer engagement; and strategy, regulatory, financial, and stakeholder management. In response, utilities should take proactive action to:

- Renew the regulatory compact
- Market, test, or pilot alternative resources
- Define adjustments to the operating model
- Define adjustments to the business model

Despite some rhetoric to the contrary, utilities will continue to exist and play a vital role in providing valuable services to customers. Therefore, utilities must have room to become valuable partners to ensure that distributed generation becomes a long-term, positive enhancement of the electric grid.

In renewable energy project development, regulatory risk can often be one of the more frustrating issues that renewable energy developers must address. To date, U.S. Department of Defense (DoD) officials, in particular, the U.S. Army Energy Initiatives Task Force (EITF), have taken a conservative approach to state regulatory risk by including requirements in requests for proposals (RFPs) that the bidder comply with all state utility laws. Understanding the nuances of state regulation may provide an opportunity for power purchase agreements (PPAs) to be executed that might otherwise not be considered readily feasible.

Federal regulation of public utilities by the Federal Energy Regulatory Commission (FERC) is relatively well-understood, and therefore is not the focus of this article.

DRIVERS OF CHANGE

Resources that have the potential to shift the utility business model are generally appearing on the customer side of the meter and providing utility customers with alternatives to supply their electricity needs that did not previously exist. Principal self-supply energy resources include solar PV, combined heat and power (CHP), demand response, and microgrids. The primary drivers propelling the growth of distributed generation resources include:

- **Technology and Distributed Generation Advances:** Advances in PV technology, coupled with commodity price declines, are introducing unprecedented levels of non-traditional generation to the grid. In addition, distribution automation, advanced and aggregated demand response, energy efficiency, and automated metering infrastructure are improving the reliability and efficiency of the grid.

- **Public Policy and Regulatory Support:** Policies driving adoption include net metering,

renewable portfolio standards with distributed generation requirements, authorization to allow third-party ownership models, and incentives. States are beginning to explore these dynamics and their impact on electric utilities and customers. Policies built around the "value of solar" or other distributed generation may become more prevalent and may replace net metering. Regulators are also encouraging utilities to explore advanced technologies and new business models. Examples of these efforts include Minnesota's value of solar, grid modernization in Massachusetts, and "utility of the future" discussions in Maryland and New York.

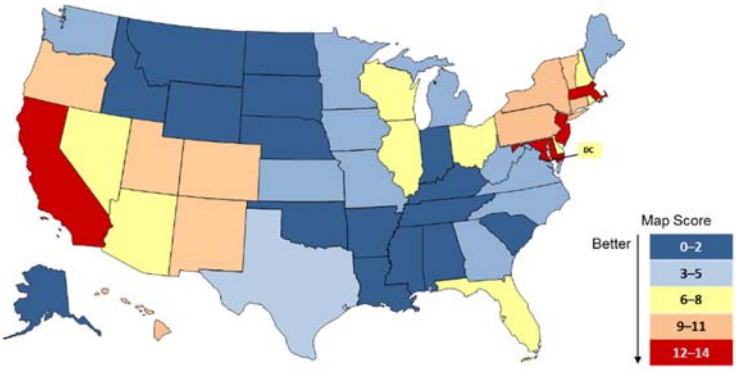
- **Customer Preference:** Businesses are demonstrating a growing interest in incorporating distributed generation in their energy supply. For example, Walmart generates 1% of its electricity or 174 GWh per year from on-site biogas, solar, and wind.[1] In addition, residential customers are considering distributed generation in growing numbers as costs continue to decline. Demographics will increase this trend as younger customers have stronger preferences for green solutions.

The adoption and impact of these drivers will not be consistent across the United States. Instead, states with more favorable environments (e.g., more lucrative net metering, third-party solar leasing and PPAs, higher electricity prices, etc.) are more likely to have a significant influx of distributed resources. The majority of these states are in the northeast and southwest.

ISSUES AND CONSEQUENCES

Distributed resources introduce complexity to traditional model of central-station generation and

EXHIBIT 1: PROSPECTS FOR DISTRIBUTED GENERATION



the long-haul transmission. The issues range from the strategic to tactical, for example:

- Third-party sales of electricity may displace the utility's role with the retail customer.
- Microgrids introduce the question of franchise rights and the definition of a utility.
- Utilities may need to upgrade distribution infrastructure (relaying, reclosers, conductors, and transformers) to accommodate two-way power flows that come from these installations.
- The utility needs to be able to "see" where resources are located on the grid and manage intermittency at the distribution level.
- Distributed resources and demand response have the potential to change the load curve of a utility in specific networks in the distribution system.
- Due to net metering provisions, distributed generation customers may not participate fully in paying for the distribution upgrades required to interconnect their rooftop solar installation.
- Some argue that cross-subsidization of rate classes is taking place in the deployment of distributed generation (beyond existing cross-subsidization of low-income and between other

[1] U.S. EPA, "Top 30 On-site Generation, Revised January 27, 2014," http://www.epa.gov/greenpower/toplists/top30onsite.htm

rate classes, i.e. between industrial, commercial and residential).

- Large corporations, which are utilities' largest customers, are facing pressure from produced products and services.

TODAY'S UTILITY ACTIVITY

Utilities are contemplating the degree to which they want to own or operate distributed generation assets. There is particular interest in solar PV assets and that is the focus of this section. Approaches to this technology fall broadly into the following categories:

- **Finance Outside of Service Territory:** Companies may pursue opportunities by providing project financing or equity investments in companies. In 2010, Pacific Energy Capital (a subsidiary of PG&E) agreed to fund SolarCity to install solar on homes and businesses. Examples of equity investments, which appear to be the preferred approach in recent years, include Duke Energy's investment in Clean Power Finance and Edison International's acquisition of solar installer SoCore Energy.

- **Own/Operate Outside of Service Territory:** Numerous utilities have invested in utility-scale solar outside of their service territories to learn about the technology while potentially increasing earnings. Direct ownership of distributed solar has been more limited. However, Integrys announced in January 2014 that its subsidiary, Integrys Energy Services (IES), would invest $40 to $50 million per year in commercial and residential solar. Clean Power Finance will provide origination and operation services, while IES remains the owner of the solar assets.

- **Provide "Green" Options to Customers:** Utilities may meet customer needs by providing community solar initiatives or green rates. For example, Salt River Project offers customers access to a 20 MW community solar project. Meanwhile, Duke Energy, NV Energy, Dominion, Georgia Power, and others provide credits or tariffs for customers to purchase renewable energy, thereby eliminating the need for customer-sited infrastructure from their perspective. The utility benefits because these resources are generally utility-scale and have minimal impact on the distribution system.

- **Own/Operate within Service Territory:** Utility-owned distributed solar may become a regulated asset within a company's service territory. This approach mitigates issues related to net metering while providing operational benefits, as the utility can potentially site the solar in the part of the system best equipped to accommodate it, and where it may help solve congestion or reliability issues. Dominion is testing utility-owned distributed solar in a 30 MW pilot program.

In addition, some utilities have begun to contemplate a role akin to a distributed regional transmission organization (RTO). In this scenario, the utility becomes a manager of transactions across a diverse set of resources including distributed generation, demand response, energy efficiency, and customer loads. This model presupposes changes to rate design and significant advances in utility operations.

EXHIBIT 2: BENEFITS AND CHALLENGES OF CURRENT UTILITY ACTIVITY

Types of Utility Involvement	Benefits	Challenges
Finance Outside of Service Territory Own/Operate Outside of Service Territory	▸ Allows for participation in growing market and potential return on investment through direct (energy revenues, renewable energy certificates) and indirect benefits (tax credits, diversification) ▸ Facilitates an understanding of technology and market considerations	▸ Technologies and regulations outside of the service territory may not provide adequate knowledge transfer for future service territory installs
Provide "Green" Options to Customers Own/Operate within Service Territory	▸ Provides an opportunity to gain first-hand knowledge of how to maximize resource value ▸ Understanding technology may provide ancillary benefits (e.g., voltage regulation) ▸ More likely to be eligible for rate recovery	▸ Requires larger investment in capital and resources to acquire and manage ▸ Needs to be coordinated with other facets of the company

OVERVIEW OF UTILITY COURSES OF ACTION

A utility should begin by evaluating the potential market size of distributed generation in its service territory. Key drivers will be the local renewable resources, installation costs, and policy structure. With an understanding of the potential market, a utility should follow the steps below.

- **Renew the Regulatory Compact:** The current rate model was designed for a different environment. The convenience of cost allocation to a few major rate classes, using volumetric rates, breaks down in a world of varied and distributed customers. If distributed resources are to see long-term, viable penetration, this model must be rethought. The utility risk profile, business model, and financial structure all depend on the regulatory contract. Key actions to renew the regulatory compact include:
  - Addressing net metering inequality issues
  - Immunizing returns against flat to declining consumption through rate decoupling or other mechanisms
  - Protecting franchise rights and responsibilities
  - Creating grid-reliability interconnect and operating protocols
  - Creating flexible tariffs to serve distributed generation customers
- **Market Test or Pilot Alternative Resources:** Market tests and pilots allow utilities to develop operational experience with new technologies. Utilities may also test pricing principles through market experiments and differentiated pricing. Market tests or pilots within a service territory may establish a precedent for full-scale implementation.
- **Define Adjustments to the Operating Model:** Utilities will need to refine operating models to account for the lessons learned through market tests and pilots. Key areas of focus include real-time operations, system planning, and customer engagement (see exhibit 3).
- **Define Adjustments to the Business Model:** Utilities must also refine business models based on the lessons learned from the market test or pilot. Key areas of focus include strategy, regulatory, financial, and stakeholder engagement (see exhibit 4).

EXHIBIT 3: OPERATING MODEL ADJUSTMENTS

Areas of Concern	Implications	Considerations
Real-Time Operations	▸ A market test or pilot will allow operators to see and operate new resources connected to the grid	▸ Consider expanded, more granular visualization tools ▸ Determine how coordination with non-utility entities that operate assets should work ▸ Protocols dictating the availability of resources may become important if they are to be relied upon by operations
System Planning	▸ Central station generation and long-haul transmission planning will need to incorporate a market test or pilot	▸ Models need to account for new resources ▸ Location and time are now important variables and need to be considered both in transmission and distribution
Customer Engagement	▸ A market test or pilot allows utilities to provide customers new services	▸ The utility will be called upon to interconnect to various entities; the roles and responsibilities in that interface need to be clear ▸ Customers may require additional types of service

EXHIBIT 4: BUSINESS MODEL ADJUSTMENTS

Areas of Concern	Implications	Considerations
Strategy	▸ The utility will face competition and loss of revenue ▸ Alternative business opportunities may exist	▸ The utility needs to consider which businesses it wants to be in ▸ Is there an opportunity to become the "single point of contact" to the customer? ▸ Are there other lines of businesses the utility should enter?
Regulatory	▸ Utility loads will decline with the influx of resources; the existing rate construct may be insufficient to address declining demand growth and customer generation	▸ Consider rate decoupling, riders, and other strategies to protect revenues today ▸ Open the dialogue with the regulator on changes to the business model and the "value of the grid" ▸ Consider further bifurcation of customers and rate classes
Financial	▸ Customers are using less electricity or self-supplying	▸ Clarify approach to net metering ▸ Consider new growth strategies (e.g., electrification of infrastructure, etc.)
Stakeholder Management	▸ A strategy to manage all stakeholders will be critical	▸ The utility needs to manage and communicate to all stakeholders through transition ▸ This approach should be coordinated with other strategies

Despite some rhetoric to the contrary, utilities will continue to exist and play a vital role in providing valuable services to customers. Therefore, utilities must have room to become valuable partners if we are to ensure that distributed generation becomes a long-term, positive enhancement of the electric grid.

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Distributed Energy: Understanding and Mitigating Commercial and Regulatory Risks

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Improving technology, combined with higher costs of traditional grid-delivered electricity and increasingly stringent environmental requirements, have created new opportunities for on-site power and other distributed energy resources (DER).

According to the U.S. Energy Information Administration, 42 gigawatts (GW) of new peak power generation capacity will be needed in the next twenty years.[2] Much of this capacity will be met with DER, driven by energy consumers seeking improved performance, reliability, power quality, and cost savings. Several Fortune 100 companies, including Wal-Mart, Google and Apple, have committed to supplying all of their energy needs through renewable energy resources.

A number of states are pursuing aggressive programs providing incentives and regulatory reforms supporting adoption of DER. Most recently, on April 25, 2014, New York State Governor Andrew Cuomo announced that the N.Y. Public Service Commission will overhaul the state's energy market regulations with the goal of increasing distributed generation, smart grid, and demand response technologies. Public utility commissions in California, Arizona, Colorado, Minnesota, Florida, Hawaii, and Iowa have open dockets addressing DER adoption and related ratemaking issues.

These market and policy dynamics are leading to increased adoption of DER. Growth has accelerated substantially in the market for commercial and industrial DER systems ranging from 1 megawatt (MW) to 3 MW in scale. For example, distributed solar energy capacity was the third largest source of new generation in 2013, and is expected to grow at a rate of 22% annually through 2020.[3] While solar PV has been at the forefront, the DER opportunity is much larger than solar, encompassing a variety of distributed generation technologies, including modular wind, combined heat and power, biomass, biogas, fuel cells and micro-turbines, as well as, other resources such as energy storage, microgrids, demand response, and advanced energy management information technologies.

On the other hand, electric utilities and broader national organizations have increasingly sought to restrict and impose additional financial charges on DER. They argue that consumers obtaining power through their own generation assets are not paying enough for general grid services.

The shift toward DER is creating major opportunities for investors, although in a context of increasing uncertainty. Innovative financial models can be used to structure DER investments, particularly those focused on aggregating pools of assets for investment and securitization. Given the complexities of DER and the changing regulatory and market landscape, identifying risks and opportunities to mitigate these risks will be increasingly important in the context of DER investments.

[2] http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014&subject=0-AEO2014&table=9-AEO2014&region=0-0&cases=full2013full-d102312a,ref2014-d102413a

[3] Edison Electric Institute, *Disruptive Challenges: Financial Implications and Strategic Challenges to a Changing Retail Electric Business*, Jan. 2014 (citing Bloomberg New Energy Finance).

RISK CATEGORIES IN DISTRIBUTED ENERGY TRANSACTIONS

Distributed resource investments bring unique areas of risk. A number of these types of risks are commercial in nature, and will be addressed primarily on the business side of the transaction. Other types of risk are structural and regulatory in nature and will generally be handled with contractual provisions.

Commercial Risks

A key initial issue is the proposed structure of the DER investment. Financing may either be directly provided to the project site owner or to third-party providers. Transactions may employ a mix of non-recourse debt, tax-equity financing, and equity. Sponsors are able to achieve performance advantages and cost savings through a portfolio approach, and can effectively monetize the economic benefits realized through government incentives, tax credits, and depreciation. Portfolios and the associated revenue streams can then be packaged, securitized, and offered to investors. Each transaction model must be evaluated in considering the potential risks and expected upside.

Particularly in the context of third-party financing, there are a number of significant categories of commercial risks, including:

1. Technology Risks: Understanding the expected performance and reliability of the proposed technical solution is critically important. This includes both the direct operation of generating assets as well as related remote sensing and information technologies.

2. Developer Qualifications: The history and capabilities of the project developer can make the difference in achieving a successful outcome.

3. Sponsor Risk: The duties and capabilities of the sponsors/hosts of the project assets should be assessed. If the underlying assets must be accessed over time for maintenance purposes, and if the sponsors are relied on, including for ongoing operations and maintenance, these risks become more important.

4. Credit Risk: Where returns are to be provided through an arrangement with the counter-party to purchase and take the power produced, the terms and conditions of the off-take agreement will be critically important. In debt transactions, the lender also may take a security interest in the supplied power and resulting cash flows.

Regulatory Risks

Distributed generation projects are structured within a complex system of state and federal regulatory requirements. Each state regulates power generation and utility interconnection and off-take separately. Achieving financeable and successful transactions requires a clear understanding of these regulatory matters.

For example, a key question for a DER investment is whether the project would be located in states that permit third-party leasing of on-site energy resources – referred to as “retail choice” programs. Currently, such programs are allowed in twenty-three states and the District of Columbia. In states where retail choice is not authorized by statute, third-party financing is not an option, and project proponents may be required to enter into direct discussions with regulators to obtain necessary approvals for DER transactions.

Federal and state financial incentive programs also must be fully considered. The specific terms of the applicable net-metering or feed-in tariff provisions will greatly impact the economics of the transaction. Several states have passed legislation authorizing programs such as Property Assessed Clean Energy and on-bill financing. These programs have substantial impacts on investment risk profiles. Another issue is the ability to monetize renewable energy credits (RECs) and the potential for changes in REC values over time. In a number of states, renewable portfolio standards are under attack by opponents seeking repeal. In those states, the risk of

a change in law could have a significant impact on the value of RECs.

Finally, as the industry itself has recognized, the adoption of distributed energy resources is challenging the electric utility industry business model.[4] Some utilities and companies involved in fossil fuel-related sectors are responding to these developments in ratemaking cases, requesting modified rate structures that require DER users to pay additional amounts to cover "grid services" and "stand by" and backup services. Also, DER opponents are increasingly seeking repeal or modification of the underlying legislation creating renewable and DER value streams, such as state renewable portfolio standards (RPS) and tax credit programs. The potential for future changes in law and the extent of resulting impacts on DER financial returns should be carefully assessed.

DUE DILIGENCE AND CONTRACT FRAMEWORKS IN DISTRIBUTED GENERATION TRANSACTIONS

Investing in aggregated pools of distributed generation assets poses unique transactional challenges. Comprehensive due diligence, including inspections of each operating installation, may not be cost-effective. In these kinds of projects, the goal is to design and implement due diligence reviews that are sufficiently representative to achieve overall risk assessment, at a level of expense that is consistent with the returns offered by the proposed investment.

Key items for review include the investment financial model; applicable regulatory framework affecting interconnection, off-take and pricing, as well as potential for future modifications to that framework; whether the project developer has provided consistent and uniform documentation of the underlying contractual arrangements, including off-take and interconnection agreements; structure age and physical condition, ownership, and security of the assets; resource forecast data and methodology; equipment selection, design, engineering, reliability, and system degradation projections; installation quality control historical data; operations and maintenance provider and agreement terms; inspection reports from site visits at selected representative facilities; performance of sponsor portfolios in prior DER investment transactions; and warranties, performance guarantees, and insurance.

Potential investors and their counsel should consider retaining independent technical and engineering consultants to aid in designing and conducting due diligence reviews. These experts can be particularly helpful in assessing the reasonableness and uncertainty of power generation forecasts, cost assumptions and projections, and review of the O&M plans.

Similar due diligence models will need to be developed for other DER technology portfolios, including fuel cells, modular wind, and biogas/biomass applications. Increasing standardization will be important as the markets for DER projects employing these technologies mature.

The capability to standardize the due diligence process and provide effective reviews in a cost-effective manner will be a key to increased investment in DER. The ultimate goal is development and application of due diligence templates that will reliably achieve the assessment of the significant variables in a DER portfolio transaction.

Unlocking the value in distributed resources investments requires a unique blend of creativity and standardization. A typical deal package might include some combination of the following:

- Project company documents and equity agreements
- Loan and credit agreements
- Tax equity agreements
- Developer agreements

[4] *Id.*

- Lease agreements
- Power purchase agreements
- REC ownership
- Collateral security agreements
- Revenue distribution waterfall
- O&M and backup service agreements
- Insurance policies

The nature, scope, and structure of each project will necessarily determine the precise contract framework. Early and careful strategic assessment, and creative use and modification of the available contract structures, will be critically important to mitigating the project and regulatory risks, and achieving successful financial outcomes.

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S&W's Energy Finance Practice designs solutions for complex financing challenges, including the integration of new technologies and related financial innovation for the power generation industry, as well as the deployment and commercialization of advanced energy technologies and distributed generation projects.

Revisiting the Electricity System: Leveraging Distributed Generation

Steve Morgan
American Clean Energy

A resurgence of the renewable energy industry has taken place over the last decade, fueled by state mandates and federal policy incentives, as well as significant reductions in project costs. Despite the recession of 2008-2009, growth in the renewables sector particularly accelerated the deployment of wind and solar photovoltaics (PV).[5]

What was once a niche market has grown to become a business concern for utilities and regulators. However, the intermittency and low-capacity factors of wind and solar PV, relative to base-load thermal power stations, has raised operating concerns. Revenue erosion as customers use less energy and capacity of the grid, or actually generate back into the grid, creates concerns for the utility business model.

THE SHIFTING MARKET AND POLICY LANDSCAPE

Since 1983, 38 states and the District of Columbia have adopted renewable energy targets, 30 of which have mandatory compliance requirements and eight of which have voluntary requirements. In addition, 43 states and D.C. have established various net-energy metering (NEM) policies. The RPS requirements are a patchwork of policies that vary from jurisdiction to jurisdiction. Some include all forms of renewables, and 10 of them call for set-aside requirements for solar PV and/or distributed generation.

During this same period of time, utility deregulation or restructuring occurred in 16 states plus D.C., vertically disaggregating the utilities in those jurisdictions.[6] To further complicate the picture, 34 states and D.C. partially or totally participate in organized wholesale markets for electric power transactions through a regional transmission operator (RTO) or independent system operator (ISO).[7] The upshot of these changes in policy and regulation has been the return to relying on private investment for new or replacement generation assets in most, but not all of the country.

At the same time, uncertainty over future carbon regulations has all but killed new coal-fired, base-load construction. Expected future capacity will come from natural gas and renewable resources. In 2013, 37% of all new electricity generating capacity came from renewable energy, three times more generation capacity than from oil, coal, and nuclear combined. While the bulk of renewable energy additions over the past decade had been from grid-connected wind, 2013 saw the largest renewable power capacity increase from solar PV, both distributed and centralized.[8]

The problems attendant to central-station power sources affect grid-connected renewable energy projects as well, including long-distance transport of the energy to the load centers. There are substantial benefits to be derived by placing new renewable sources closer to the loads they serve.

[5] Bird, L., J. McLaren, J. Heeter, C. Linvill, J. Shenot, R. Sedano, and J. Migden-Ostrander. *Regulatory Considerations Associated with the Expanded Adoption of Distributed Solar.* (2013).
[6] Council, Interstate Renewable Energy . *Status of Electricity Restructuring by State*. EIA. 2014. www.eia.gov/cneaf/electricity/page/restructuring/restructure_elect.html
[7] AD10, Organized Wholesale Power Markets. "137 FERC¶ 61,064 UNITED STATES OF AMERICA FEDERAL ENERGY REGULATORY COMMISSION."
[8] *Solar Market Insight Report 2013 Year in Review*. SEIA. 2014

THE POWER MARKET TODAY: A NEW, OLD MODEL

Solar PV penetration has grown from virtually nothing in 2000 to about 12 GW at the end of 2013.[9] While many of the previous additions have been large-scale, grid-connected projects, smaller, distributed solar PV is expected to make up the majority of additions in coming years.

The pace of deployment has been driven by various state and federal incentives available to developers and owners. However, growth is increasingly driven by solar PV cost reductions. Since 2007, PV panel prices have fallen over 80%. Solar panels can be purchased in volume at about $0.70 per watt delivered, and continued price pressures are expected into the future.

Total installed costs range from $2.30-4.00 per watt, and little has been done to reduce the balance of systems or financing costs for PV systems.[10] However, at existing developed costs, assuming a 30-year life and a conservative estimate of future operations and maintenance (O&M), the U.S. Energy Information Administration (EIA) calculates the levelized cost of energy (LCOE) to be around $0.13/kWh.[11] Market bids have also come in around $0.08/kWh all-in, making the LCOE comparable to pre-recession, wholesale power pricing. Even at the higher, more conservative estimate of the U.S. EIA, LCOE is below existing retail rates in high-cost states like New Jersey, New York and California. Then what is preventing rapid deployment of distributed solar generation, particularly in high-cost service areas?

The barriers are numerous, but the most significant are the balkanization of markets, uncertainty of policy, over-reliance on tax-equity financing and project finance, and a general lack of understanding and inability to monetize the value that distributed generation resources bring to the grid.

Many projects sited in the distribution system will be below 1 MW of capacity, limited by both space and customer load as well as distribution system design. There has been some concern that projects of this size cannot scale because the project finance model generates a high cost of capital and legal expenses, making development economically unattractive. Given the relatively low penetration rates thus far and the raging debate over new financing tools, one must conclude that there is some merit to this argument.

However, economies of both scale and scope can be created once a substantial pipeline of projects is established. There are economies that come from both the supply chain as well as lessons learned from replication, and most economies are yet to be achieved in this market. Although, achievement of these benefits cannot be realized without a better funding vehicle than is now in place.

Tax equity financing has been an essential tool in the financing of projects to date. The explosion in solar deployments in 2010-2012 was, at least in part, the result of the conversion of incentives into cash payments under the 1603 federal cash grant program implemented to compensate for the crash of the tax equity market following the 2008-2009 financial crisis. The tax equity market has returned to pre-crisis levels but the limited availability of tax-equity investors and the high cost of capital they command will limit the industry's growth trajectory.

The rapid growth of the electric utility industry in the post-World War II era relied upon the ability of utilities to securitize their capital additions. Access to stable, predictable, long-term sources of funding can have a similar impact on the emergence of the distributed generation market. But the ability to

[9] Solar, U. S. "TRENDS 2012." (2013)., www.irecusa./publications

[10] Feldman, David, G. Barbose, R. Margolis, R. Wiser, N. Darghouth, and A. Goodrich. *Photovoltaic (PV) pricing trends: historical, recent, and near-term projections*. No. DOE/GO-102012-3839. National Renewable Energy Laboratory (NREL), Golden, CO., 2012.

[11] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *U.S. Energy Information Administration (EIA)*. N.p., n.d. Web. Apr. 2014. <http://www.eia.gov/forecasts/aeo/electricity_generation.cfm>.

finance future projects with bond proceeds is generally limited to a very few large developers. Utilities are in a position to access these capital markets at a cost and tenor that can make the deployment of distributed generation grow. After all, these resources are long-lived, utility-like assets with proven and predictable operating characteristics and lives.

Present history in the solar renewable marketplace suggests that most hosts prefer to acquire solar energy through a power purchase agreement (PPA), wherein they get stable, predictable, long-term pricing for electricity without the burdens of upfront capital or future O&M costs. This suggests that those familiar with owning and operating long-lived assets are best positioned to take advantage of the market development phase of growth.

In order for this suggested model to work, two critical ingredients are required. First, the utility must be convinced of the value proposition in moving to a more distributed generation platform. Secondly, the customer must be convinced in the long-term value proposition in allowing the distributed generation on their site/building.

Much of the current policy debate has focused around the elimination of incentives, including net-energy metering, largely driven by the concern over utility revenue erosion as market uptake accelerates. We are seeing the evolution of renewable distributed resources in the interconnected grid. The current debate has focused on who wins and who loses? There do not need to be any losers. The challenge is to craft a win-win framework.

TRANSITIONING TO FUTURE MODELS

Some suggest that the intermittent nature of solar distributed generation will cause operational issues in the interconnected grid at even modest penetration levels. The National Renewable Energy Laboratory (NREL) report, *Renewable Electricity Futures Study*, concluded that: "The central conclusion of the analysis is that renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the United States."[12]

Will there be changes and adaptations required? Certainly, but the challenges can be met and do not require unknown or unavailable technology for success.

What about customer objections to utility-owned and operated assets? From my experience, customer dissatisfaction stems from two main sources: price and availability. Customer dissatisfaction over either or both of these issues generally translates into a call for "competition" or "control."

Availability in the utility industry is generally measured as an average for all customers over a year, based on 8,760 hours per year. According to a 2012 report from Lawrence Berkeley National Laboratory (LBNL), the average outage duration and average frequency of outages for U.S. customers is increasing at a rate of approximately 2% per year.[13] A system that does not achieve 100% availability is seen as insufficient given the digital age in which we live. While the LBNL report is not conclusive as to the cause of the trend, those in the utility industry know that customer perception of reduced reliability/availability has translated into customer and regulatory pressure for change.

To some, that change requires massive new investment in capacity, which works against the primary concern of price. By some estimates, upwards of $1.5 trillion are needed to bring the system to a level of performance that would satisfy

[12] Mai, T., R. Wiser, D. Sandor, G. Brinkman, G. Heath, P. Denholm, D. J. Hostick, N. Darghouth, A. Schlosser, and K. Strzepek. *Renewable Electricity Futures Study. Volume 1: Exploration of High-Penetration Renewable Electricity Futures*. No. NREL/TP-6A20-52409-1. National Renewable Energy Laboratory (NREL), Golden, CO., 2012.

[13] Eto, Joseph H. *An Examination of Temporal Trends in Electricity Reliability Based on Reports from US Electric Utilities.* (2013).

customer demands. What if, instead of spending money to reinforce the transmission and distribution systems, we utilized distributed generation resources and semi-autonomous "smart grid" architecture to isolate an outage cause to the smallest possible set of affected customers?

The Rocky Mountain Institute's Electricity Innovation Lab issued a report summarizing the known body of work on solar PV benefits and costs.[14] In all, 15 cost/benefit studies undertaken by regulatory bodies, electric utilities, national labs, or other organizations were reviewed and assessed. Differences in methodology and assumptions make direct comparisons of the studies not useful. However, there were a number of observations that support a view that the benefits of solar PV are net positive. There is general agreement that energy cost reduction, encouraged by less energy production, energy loss reduction, and avoided capacity charges, is possible and fairly easily quantified. Likewise, it is understood that distributed generation can provide ancillary services to the transmission and distribution system by way of reactive supply, voltage regulation, frequency response, and congestion reduction, though there is no general agreement as to the value of such services. Other posited benefits such as avoided T&D infrastructure costs, elimination of criteria pollutants, water and land use, carbon reduction, jobs and economic growth, national energy security, enhanced reliability and/or resiliency, and fuel price hedging are still being debated and are not easily monetized.

The net value noted in the NREL *Renewable Electricity Futures Study* amounted to about $0.28/kWh for distributed PV, which is in the middle of the pack among the other studies. While there continues to be much debate about the proper methodologies and assumptions to use in making these calculations, it should be clear that there is sufficient benefit from distributed generation resources that, particularly given that solar PV is competitive with new sources of generation, we simply cannot ignore it.

The intrinsic value of solar PV will be realized when a utility decides to install distributed resources instead of a fossil-fueled, central-station generator or a new transmission line to eliminate or reduce congestion. Assuming a utility must make an investment in new generation, transmission, or distribution capacity to serve its load growth or replace retiring facilities, the customers benefit when that decision is displaced by distributed generation resources. Of course, this assumes significant market penetration of distributed resources are achieved.

Importantly though, the distributed generation model can be economically attractive in the existing grid architecture. The wide development of distributed generation resources is an essential, but incomplete solution for the establishment of the grid of the future. The addition of "smart" inverters and distributed energy storage promises to take the grid to its ultimate performance. Smart inverters, capable of autonomous or semi-autonomous operation, already have the ability to provide volt/var regulation and islanding capabilities in the event of loss of the grid for outage events. Coupling this capability with distributed energy storage technology, whether collocated with distributed solar PV or not, effectively makes those resources "dispatchable." The distributed energy storage can be used to mitigate or eliminate any intermittency, provide frequency regulation and demand response services, and help load shaping to maximize the value of the solar resources.

In combination, distributed solar PV and distributed energy storage, coupled with smart-grid enabled equipment, can provide significant reduction in both customer outage frequency and duration, which helps achieve the long-sought-after "self-healing" grid.

[14] Branker, K. M. J. M., M. J. M. Pathak, and Joshua M. Pearce. "A review of solar photovoltaic levelized cost of electricity." *Renewable and Sustainable Energy Reviews* 15, no. 9 (2011): 4470-4482.

A viable business model already exists. Utility ownership of these distributed resources obviates the need to eliminate balkanized policies, provide new or renewed financial incentives, or provide new tools to access capital markets, all the while ensuring rapid deployment and long-term, stable ownership and management of the assets for the benefit of the utility, its customers, and ultimately the nation.

This is not a call for utilities to become large-scale engineering, procurement, and construction (EPC) contractors or to insource the development process. Just as utilities do not design or construct large-central-station generation and contract out T&D design and construction work, they can rely on the already available pool of developers and EPC contractors for the essential work. Rather, this is a call for them, in exchange for all of the benefits enumerated, to bring their financing muscle to the task of funding build out and to utilize their expertise in the integration of these assets into the grid of the future.

No doubt there are skeptics of such a model, but it is relevant to point out that over the last 130 years, the electric utility industry has created one of the greatest machines known to humankind: the interconnected grid. Access to readily available and cheap energy has been the engine of the U.S. economy for at least the past 50 years. A look at U.S. EIA data over that period reveals that the "real" price of electricity delivered at the end of 2010 was the same as it was in 1960. Over that period of time, electricity prices were effectively indexed to GDP growth, and the data indicates that productivity improvements, brought about through the electrification of work, were the reason. The next 100 years can achieve at least the same benefit, all the while securing the nation's economic, energy and environmental security.

Using a rate-based, rate-of-return approach eliminates many of the barriers presently preventing rapid scaling of renewable distributed resources. Providing the utility with a reasonable return and earnings on its investment over the asset life, in return for using its balance sheet to access cheap capital markets, is the model that built the existing grid and provided the energy that fueled our economic growth. Utilization of this model to build renewable generation and eventually storage technologies will allow us to unlock the value of distributed energy resources in a way that benefits all constituencies – utilities, customers, and regulators – through stable and affordable energy supply, a more resilient and capable grid for this next century, and a safer, cleaner and more secure world.

ABOUT THE AUTHOR

Steve Morgan is the CEO of American Clean Energy, a New Jersey based solar developer. Prior to forming the company in 2009, Mr. Morgan spent 33 years in the electric utility industry, retiring as the CEO of Jersey Central Power and Light Company, a subsidiary of FirstEnergy Corporation. He was recently elected to the Board of Directors of SEPA and has served since 2010 on the Board of ACORE and is active on a number of other boards in NJ. More info can be found at www.amcleanenergy.com

Role of Industrial and Commercial Energy Users in Changing Utility Business Models

Shalini Ramanathan
RES Americas

Commercial and industrial electricity users increasingly purchase renewable power to support sustainability targets. Purchases include behind-the-meter rooftop solar and financial settlements for bulk wind power. The role of electric utilities, the traditional buyers of renewable energy, varies in these transactions. Some commercial or industrial electricity users work through utilities, while others directly handle purchases. There are advantages and disadvantages to each approach. Utilities will likely react to this trend by offering products and services to commercial and industrial users and by changing the way they charge for grid services.

RENEWABLE POWER AND COMMERCIAL AND INDUSTRIAL USERS

For many years, owners of large wind and solar projects had just one type of customer: electric utilities. Now, in addition to selling to utilities, it is possible to sell renewable power directly to large end-users of electricity, such as retailers, manufacturers, or technology companies with large data centers. The interaction between independent power producers (IPPs), utilities, and commercial and industrial users is changing. The role of utilities varies in each transaction as new models are developed.

Commercial and industrial users can be major customers for utilities. Retailers' aggregate loads and technology companies' data centers are significant power customers. A large data center, for example, may require 80 MW of power, equivalent to the electricity used by approximately 80,000 average households.[15] Because there are few new aluminum smelters or cement manufacturing plants being built in the US, retailers' aggregate loads and tech companies' data centers are significant power customers. What these customers do is important to utilities, to IPPs, and to the electricity sector overall.

Why might a commercial or industrial customer work with a utility instead of directly procuring power? Electricity is a complicated, highly regulated business, and, if your business is widgets, you might prefer to remain focused on widgets. Unless there is an existing power management program, living up to the terms of a power purchase contract may require new expertise and compliance measures. Because a big retail store or manufacturing plant will likely be connected to the grid, even if it has solar on its roof, it may be easiest to meet all power needs, including renewable energy, through the local utility.

Accounting rules may also play a role. Many power purchasers, whether they are utilities or commercial or industrial users, prefer receiving fixed blocks of power instead of taking unit-contingent, intermittent power as produced. Structuring a power purchase agreement (PPA) to buy fixed blocks of power may make it a derivative instrument, triggering complicated mark-to-market accounting treatment.

Furthermore, power contracts are long term. While wind and solar prices are at all-time lows, and these technologies are a good hedge against rising power prices, it can be challenging for companies whose core business is not power to take a long-term view on power price curves in this market. A utility must have a long-term view on power-price curves, and it

[15] John Finnigan, "Big-Box Retailers Turn To Solar, How Can Electric Utilities Adapt?," Environmental Defense Fund (August 9, 2013), http://blogs.edf.org/energyexchange/2013/08/09/big-box-retailers-turn-to-solar-how-can-electric-utilities-adapt/

has the ability to socialize the cost of renewable power among its customer base. Utilities may also be more comfortable stepping into renewable production ownership if required due to counterparty failure to perform under a PPA, a role that may be too far removed from the core expertise of commercial and industrial users.

On the other hand, some commercial and industrial energy users may prefer to directly negotiate power purchase contracts with IPPs to secure favorable terms and use the force of their brand and balance sheet to drive down price. Companies such as Apple and Wal-Mart, with their strong credit ratings and ample cash reserves, are attractive counterparties. And if a company is using hedges to manage exposure to energy inputs, managing obligations under a PPA may not require additional staff or expertise. Direct negotiation with IPPs reduces (if not eliminates) the need for regulatory approval of purchase agreements, which can introduce uncertainty into the execution of a deal where the commercial terms have been negotiated.

UTILITY ROLES

The role of utilities in the commercial or industrial procurement of renewable power has varied:

- Wal-Mart has nearly 89 MW of rooftop solar across its facilities and now uses more solar power than 38 U.S. states. Third-party companies install and maintain most of the solar systems and sell the power to Wal-Mart through PPAs. These arrangements look a lot like residential solar, with limited roles for utilities.[16]
- Apple announced earlier this year that its new sapphire glass manufacturing plant in Arizona would run fully on clean energy. The company has negotiated with the Arizona utility, the Salt River Project (SRP), for renewable power supply. Neither SRP nor Apple have shared details on how much power the new facility will use, though SRP has recently entered into contracts for 75 MW of renewable power.[17]
- In a related example, in North Carolina, Apple and Google have encouraged Duke Energy in North Carolina to expand its renewable power procurement. Apple has two solar projects of 20 MW each that it owns and operates to power its data centers, with only a small role for the utility. Duke Energy won approval from its regulators in late 2013 to procure more renewable energy, and charge a premium if necessary to tech companies and others willing to pay the higher price. In this case as in Arizona, tech companies have encouraged the utility to expand its renewable energy offering, while creating a new model that charges those who choose renewable power a higher price if necessary. This addresses concerns about affordability and impact on a utility's other customers.[18]
- Microsoft signed a contract last year to buy power from a wind project in North Texas.[19] The company will continue to receive electricity grid services from CPS, the municipal-owned utility in San Antonio, for its local data center. The financial settlement contract, which makes the new wind project possible and adds to the amount of renewable power on the Texas grid,

[16] Tom Randall, "Wal-Mart Now Draws More Solar Power than 38 US States," Bloomberg (October 25, 2013), http://www.bloomberg.com/news/2013-10-24/wal-mart-now-has-more-solar-than-38-u-s-states-drink-.html

[17] Michael Graham Richard, "Apple Wants Its Massive Arizona Sapphire Plant to Run on Renewable Energy from Day One," TreeHugger (February 12, 2014), http://www.treehugger.com/green-investments/apple-wants-massive-arizona-sapphire-plant-run-renewable-energy-day-one.html

[18] Katie Fehrenbacher, "Pushed by Internet Companies, Utility Makes Progress to Sell Clean Power in North Carolina," Gigaom (November 15, 2013), http://gigaom.com/2013/11/15/pushed-by-internet-companies-utility-makes-progress-to-sell-clean-power-in-north-carolina/

[19] Robert Bernard, "Microsoft Signing Long-Term Deal to Buy Wind Energy in Texas," Microsoft (November 4, 2013), http://blogs.msdn.com/b/microsoft-green/archive/2013/11/04/microsoft-signing-long-term-deal-to-buy-wind-energy-in-texas.aspx

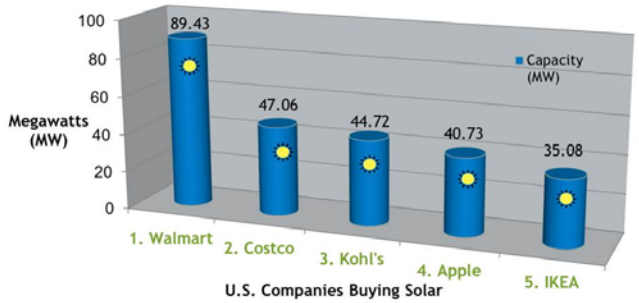
allows the company to buy renewable power from a location that it believes has pricing and interconnection advantages instead of being limited to the location of its data center. No utility is involved in the deal with the IPP, and CPS continues to serve Microsoft in San Antonio.

WHY THE CHANGE?

There are a few reasons behind the changing role of commercial and industrial customers in procuring power directly. First, the emergence of deregulated markets allows for commercial and industrial companies to act as market participants and buy power to meet their needs. In markets where utilities hold monopolies, direct purchases with IPPs can be difficult or even illegal.

Second, large companies are greening their power purchases as part of overall sustainability and corporate social responsibility goals. Many have adopted climate mitigation or renewable energy targets. For example, IKEA has announced that it will use 100% renewable energy by 2020. While many companies have met goals by purchasing renewable

Top Commercial and Industrial Solar Buyers



Source: Solar Energy Industries Association
http://www.seia.org/research-resources/solar-means-business-2013-top-us-commercial-solar-users

energy credits (RECs), there is growing recognition that buying renewable power in a way that adds more clean energy to the grid has a greater environmental impact than do REC purchases.

Additionally, tech companies are sourcing renewable power for their data centers. These companies, and their consumers, know that using digital devices is only renewable if the data centers behind them use clean energy.[20] The *New York Times* calculated that, globally, data centers consume 30 billion watts of electricity, the equivalent of 30 nuclear power plants. One quarter to one third of that power usage is tied to U.S. users.[21]

Finally, the dramatic fall in solar prices has led to commercial and industrial users buying power from behind-the-meter solar installations, similar to residential users adopting rooftop solar. The fall in wind power prices makes direct procurement by commercial and industrial users attractive in deregulated markets, where the power added can renewable the overall grid without necessarily being delivered to the point of power usage.

GOING FORWARD

As commercial and industrial customers step up their renewable power procurement, it will be interesting to see if utilities offer special services to these customers. A utility could, for example, offer to handle power dispatching and market interfacing for a fee. Or a utility could offer solar or wind to its customers to retain them, either competing or collaborating with IPPs. Increases in fixed charges for being connected to the grid (even if a facility has solar installed or procures wind) seem inevitable for commercial, industrial and residential solar adopters, as does a fresh look at any net metering plan that a utility sees as harming its long-term interests.

Utilities could also partner with city or state governments to offer renewable energy as part of

[20] Reuters, "Apple, Facebook, Google Internet Data Centers Getting Greener, Report Finds," Fox Business (April 2, 2014), http://www.foxbusiness.com/industries/2014/04/02/apple-facebook-google-internet-data-centers-getting-greener-report-finds-806649195/

[21] James Glanz, "Power, Pollution, and the Internet," The New York Times (September 22, 2012), http://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html?pagewanted=all&_r=0

economic development efforts to attract investment. Tesla has announced that its battery factory, planned to be the largest in the world, will be powered by renewable energy. The factory's site has yet to be selected, and several states are vying for the investment. It is possible that an enterprising utility will offer to procure renewable energy at a low, fixed price as part of a broader effort to attract Tesla's investment. The same dynamic could hold for car companies, large data centers, or any other source of new load and investment.

Finally, some utilities (with their regulators' approval) may decide to own projects that supply renewable power to commercial and industrial users for the benefits they provide. Putting projects in a utility's rate base would allow it to earn a regulated rate of return while protecting market share. Utilities wishing to do this will have to convince their regulators that potential increases in the cost of power for all users are justified to avoid the loss of customers, which in itself could lead to higher rates for those not opting to secure their own renewable power.

We are in the early days of bulk power users procuring their own power. More innovation and greater collaboration, as well as greater competition among utilities, IPPs, and commercial/industrial users, are surely coming.

ABOUT THE AUTHOR

Shalini Ramanathan is VP Origination for RES Americas, a leading developer and constructor of utility-scale wind and solar projects. Ms. Ramanathan has closed multiple deals with nearly $2B in total transaction value. She currently leads the company's efforts in securing renewable power and renewable project sales opportunities and previously led South Central development efforts.

Prior to joining RES Americas, Ms. Ramanathan was based in Nairobi, Kenya and worked on renewable energy projects across East Africa for the British company CAMCO. She previously worked for the National Renewable Energy Lab (NREL).

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Market Spotlight: Grid Integration Challenges and the Role of Concentrating Solar Power

Frank (Tex) Wilkins, Arthur Haubenstock, Kate Maracas, and Fred Morse
Concentrating Solar Power Alliance, Perkins Coie LLP, and Abengoa Solar

Concentrating solar power (CSP) with thermal energy storage (TES) can address mounting problems associated with integrating renewable power into the grid, enabling renewable resources' share of the energy supply to grow while maintaining grid reliability. Growing concerns about over-generation (projected to increase exponentially as renewables approach 50% of the energy supply) and solar and wind variability can be mitigated by CSP with storage. CSP with storage acts as a catalyst, allowing increased solar and wind without adding carbon or other emissions associated with the "peakers" that might otherwise be needed for reliability – while providing substantial quantities of clean power.

BACKGROUND

CSP uses mirrors to concentrate sunlight on a receiver, heating fluids to upwards of 1,000°F or more. The heated fluid can either produce steam immediately, driving turbines just like those in fossil-fueled plants to produce electricity, or the heated fluid can be stored to generate power at a later time. The ability to store and produce energy at any time means CSP is dispatchable—i.e., able to provide or withhold power as needed by the grid, thereby enabling the grid to absorb more renewables that are less flexible.

Of the multiple technologies that comprise CSP, two are now being commercialized: parabolic troughs and power towers. The most recent CSP+TES plant in the U.S. is the 280 MW Solana parabolic trough facility, in Gila Bend, Arizona. Solana has six hours of storage, allowing it to convert heat stored in molten salt form to electricity at any time, day or night. On a typical summer day, for example, Arizona Public Service (APS) could dispatch Solana to generate electricity for up to six hours after the sun goes down, to supply air conditioning demand through a warm evening. On a cold winter day, APS could dispatch Solana to start operating at 4 am, provide electricity until the end of the morning peak, then come back on line for the evening peak.

As with conventional energy resources, the market for CSP and other renewable energy resources is driven, in part, by government policies. While these policies have been successful in encouraging private sector investment and deployment, reliability and cost issues have arisen due to lack of attention to the need to procure a balanced mix of diverse resources as renewables' share of the energy supply increases. Germany, with the world's highest renewable energy levels, is going through "the worst structural crisis in


Solana, Gila Bend, AZ, Source: Abengoa

the history of energy supply," according to Peter Terium, CEO of RWE, the country's second largest utility.[22] Similar concerns have echoed in Italy, Spain, and elsewhere in Europe." Here in the U.S., California has made remarkable progress towards its 33% renewables portfolio standard (RPS) while maintaining reliability and minimizing cost increases, in part due to the grid flexibility provided by its hydropower and its mild climate.[23] Nonetheless, similar issues to those experienced in Europe are beginning to emerge; to maintain an affordable, reliable grid as renewables increase, their lessons must not be ignored.

Governments promote renewable energy to achieve several important objectives: energy security, improved air quality, and climate protection. To meet these objectives, while maintaining grid reliability and minimizing undue costs, a diverse portfolio of renewables that collectively support grid needs is vital.

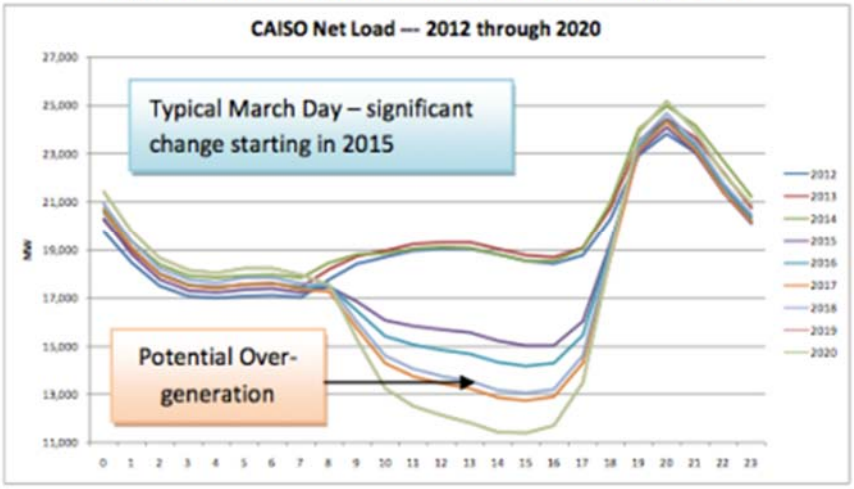
INTEGRATION OF RENEWABLE ENERGY

The grid is a highly complex system. As renewable portfolio standards increase, several grid-related concerns emerge, including over-generation (which can destroy key grid elements), fluctuations in power, lack of predictability, and steep ramp rates (i.e., the rate at which the net power load changes).

Figure 1, sometimes called the "duck curve", portrays the California Independent System Operator's (CAISO) projection of grid requirements as California approaches its 33% RPS. It shows the net demand (load) that CAISO must meet after wind and solar power is added to the grid. In the middle of the day, generation could exceed demand; when the sun goes down and nondispatchable solar wanes, the net evening peak soars, causing a particularly severe upward ramp rate. Recent analysis by Energy + Environmental Economics (E3) concludes that over-generation will be the largest renewable energy integration challenge, estimating that "over-generation will increase exponentially at RPS levels approaching 50%."[24] Over-generation would require generators to reduce (curtail) output, reducing their income and becoming an economic threat to them. While some suggest the "duck curve" and the E3 conclusions represent worst-case scenarios, the seriousness of the risks they portray are widely recognized.

Generation resources called "peakers" have traditionally provided the precise, continuous balance between supply and demand needed for grid reliability. Within this decade, increased renewables would require peakers to operate at or near their reliability thresholds, and to ramp up and down at rates that may be difficult to achieve—

Figure 1: Net load pattern changes 2012 through 2020



Source: CAISO

[22]Steitz, "Germany's utilities struggle to adapt to renewable revolution," (Reuters Feb. 3, 2014), *available at* http://www.reuters.com/article/2014/02/03/uk-germany-utilities-idUKLNEA1200D20140203

[23] California Public Utilities Commission, "Biennial RPS Program Update," (Feb. 2014), *available at* http://www.cpuc.ca.gov/NR/rdonlyres/F39A3D4C-6EE9-48AA-A0C9-03D6A3B3EF38/0/Section_399_19_Report_FINAL.pdf

[24] *Investigating a Higher Renewables Portfolio Standard in California*, Energy and Environmental Economics, Inc., January 2014, available at https://ethree.com/documents/E3_Final_RPS_Report_2014_01_06_with_appendices.pdf

increasing their emissions, as well as their costs. For example, the highest average ramp rate in California is presently about 30 MW per minute. By 2020, it is estimated to be three times higher.[25] These challenges may increase as intermittent renewable levels increase, and threaten to undermine renewable policy objectives – and erode public support for these policies. CSP+TES can mitigate these problems while decreasing emissions.

CSP ENABLING HIGHER RPS LEVELS

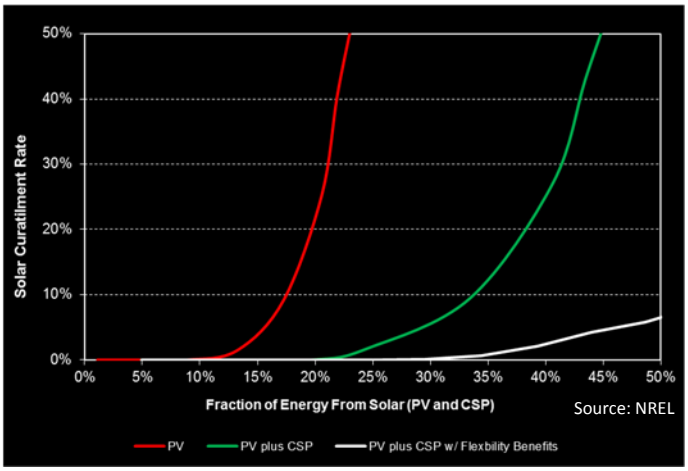
The Regulatory Assistance Project (RAP) takes a positive outlook on high renewable penetration,[26] indicating CSP+TES, along with other clean energy resources — such as electrical storage, demand response, and energy efficiency — can cost-effectively address grid reliability concerns.

CSP+TES offers essentially all the electric power products and services provided by fossil-fueled plants, without their carbon and other emissions. CSP+TES provides capacity and operational attributes the grid needs as renewables increase, such as fast-ramp rates that can be sustained for multiple hours. As a synchronous, steam-cycle resource, it can provide regulation services that "shore up" intermittent generation resources, while contributing carbon-free energy. CSP+TES also provides other vital grid services such as voltage support, frequency response, spinning and non-spinning reserves.

CSP's ability to store energy adds flexibility to the grid. Several studies quantify the comparative value of power from CSP+TES. Lawrence Berkeley National Laboratory estimates CSP+TES with six hours of storage would provide $0.035/kWh more value than solar without storage.[27] The National Renewable Energy Laboratory (NREL) came to a similar conclusion, estimating the range of additional value of CSP+TES as $0.03 to $0.04/kWh.[28] Notably, these studies focus only on the flexible reliability benefits that are most critical as RPS targets increase; they do not attempt to calculate the value of the other grid benefits CSP+TES provides.

In a further report, NREL provided additional analyses of CSP+TES' ability to address emerging changes to the energy load curves.[29] Like the E3 report, NREL found that marginal curtailment increased rapidly after threshold levels of nondispatchable solar were added to the grid; however, it also found that adding CSP+TES can significantly *decrease* curtailment, increasing the effectiveness of the nondispatchable solar.

NREL's chart (on the previous page) shows how CSP and PV complement one another. NREL's projection shows three curtailment rates: for PV alone, PV plus CSP+TES, and PV plus CSP+TES assuming CSP+TES is not dispatched to provide the flexibility benefits it could offer. The red "PV" curve shows significant curtailment once PV reaches ~14% of grid power (the projected PV level for California's 33% RPS). The green "PV plus CSP" curve shows curtailment decreases when PV and CSP provide power during



[25] *Flexible Supply and Renewable Energy: Solar and the Impact on Load Curves*, Mark Rothleder, August 2013, available at http://www.epri.com/About-Us/Documents/Summer%20Seminar%20Presentations/3.2_Rothleder_CAISO_FINAL.pdf

[26] Available at http://www.raponline.org/featured-work/teach-the-duck-to-fly-integrating-renewable-energy

[27] *Changes in the Economic Value of Variable Generation at High Penetration Levels: Pilot Case Study of California,* Mills, A., and R. Wiser, June 2012b, LBNL-5445E (at 10% solar penetration)

[28] *A Preliminary Analysis of Concentrating Solar Power with Thermal Energy Storage in a CAISO 33% RPS Scenario,* Denholm, P., et al, March 2013, NREL/TP-6A20-58186

[29] *Enabling Greater Penetration of Solar Power via the Use of CSP with Thermal Energy Storage*, Denholm, P., Mehos, M., NREL/TP-6A20-52978, November 2011

the day and CSP provides additional morning and evening power to reduce some curtailment. The white curve shows the impact of CSP+TES when it provides additional flexibility in the form of higher turndown.[30] More analysis is needed, but this study suggests high renewable portfolio standards can be implemented without loss of grid reliability when CSP+TES is added to the portfolio.

CONCLUSION

Current approaches to procuring renewable energy could lead to an unnecessarily unstable grid and increased costs, ultimately stunting renewable energy growth. CSP+TES could provide a cost-effective means to increase renewables penetration while maintaining a stable grid. A revised procurement process, intentionally targeted to achieve a least-cost, least-emissions and reliable grid, would enable CSP+TES and other solutions to contribute to a clean energy future.

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[30] "Turndown" refers to the operation of a power plant below its rated capacity. Coal and nuclear plants have historically been designed to provide baseload power. They operate at least cost and highest efficiency when at full capacity. They can, however, operate at partial load although doing so accelerates damage. CSP plants, on the other hand, are designed to operate at partial load. In this report, NREL assumed CSP plants could operate as low as 20% rated capacity (a turndown factor of 5) and that coal and nuclear plants could operate as low as 50% rated capacity (a turndown factor of 2).

Market Spotlight: Electric Vehicles: Flexibility, Creativity, and Profit Potential for Utilities

Chris King
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Utilities need greater flexibility in order to survive and thrive in a radically shifting energy landscape. As vastly more renewable resources have been added to the grid (and even more are poised to come online), utilities are racing to adapt their operations to peak demand patterns, which have significantly changed in just the last two years.

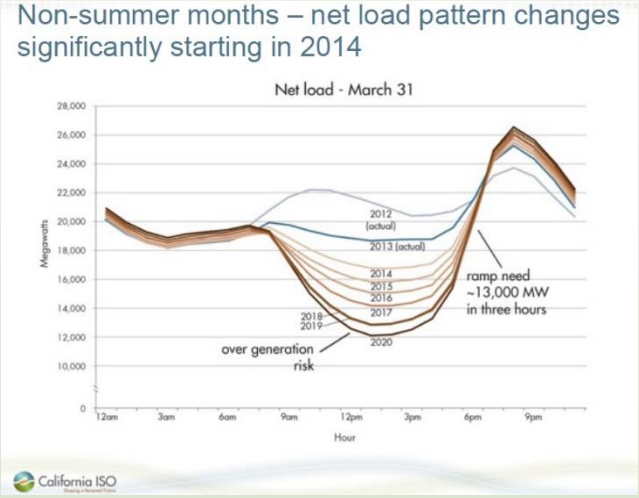
Electric vehicles (EVs) represent one of the greatest opportunities on this front. EVs can help utilities enhance reliability, implement demand response, and even develop new revenue streams — all while meeting crucial consumer transportation needs, and also while helping the environment. Pilot programs and EV research in the U.S. and elsewhere are demonstrating this value and yielding practical lessons for large-scale EV deployment and vehicle-to-grid strategies. EVs also are crucial to developing a network of microgrids to enhance reliability and manage demand.

Utilities and regulators can work together to realize the full potential of EVs in the smart grid. Third-party providers of charging-station infrastructure also have an important role to play in expanding consumer EV adoption. Together, these stakeholders can build a more resilient energy system in the U.S. and around the world.

THE EVOLVING SYSTEM PEAK: EVS FOR DEMAND RESPONSE

Peak demand is not what it once was. Traditionally, system demand would peak during hot summer afternoons, and net load — actual demand on the system minus generation from variable renewable resources — would predictably crest in the hours before and after this peak. Back then, utilities would ramp up production from conventional power plants to meet most of this demand, because contributions from renewables were relatively modest.

However, as more renewable resources are being added to the grid, this picture is becoming inverted. In particular, solar power production peaks from mid-morning through the afternoon. As solar energy becomes more common, there may be too much grid power availability in the afternoon and may be not enough shortly after sunset.



Above: The "duck curve," updated March 2014 based on actual system data, shows that in the last two years peak demand trends have shifted radically in California, largely due to the impact of a significant increase in renewable generation.

Source: Courtesy California ISO

Data from the California ISO[31] shows the first appearance of this shift in 2013, and it has quickly grown more pronounced to date. Projecting ahead,

[31] *Demand Response and Energy Efficiency Roadmap: Maximizing Preferred Resources*. California Independent System Operator, December 2013, p. 7 ("The Duck Curve"): http://www.caiso.com/Documents/DR-EERoadmap.pdf

by 2020, this trend could yield costly and risky spikes and troughs in net load — which system operators would struggle to address through conventional means.

The grid needs to be far more flexible, mostly on the demand side, in order to respond to such growing fluctuations in available power. Widely deployed EVs can supply much of this flexibility. EVs can help minimize the need to build new power plants, enhance large-scale demand response, and ultimately even reduce wholesale power prices.

As long as an EV is plugged in, it can be charged at any time — especially during off-peak hours. Also, the car's battery could be used as a power resource by utilities during times of lower power availability, or for emergency home power during outages. And all of this can be achieved without sacrificing the paramount consumer priority of on-demand transportation.

Price signals, such as time-of-use (TOU) rates, are the key to tapping EVs as a flexible grid resource. Right now, TOU rates are not available to most U.S. consumers — but with stronger regulatory support, they could be.

The potential for price signals to help address many of the most pressing challenges facing power systems is one of the most intriguing opportunities that regulators can explore, and with which utilities can experiment. Consumers are already using smart thermostats to respond to price signals – and some are translating this to EVs, where EV TOU rates are available.

For instance, for several years now, Commonwealth Edison and Ameren[32] have offered the option for their Illinois customers to sign up for real-time market pricing for electricity. So far, about 10,000 residents in the state have signed up for these rates. It is unknown how many residents also own EVs, but those who do could easily save money by charging such a significant load during off-peak times.

EVS IN THE REAL WORLD: PILOT PROGRAMS

Recently, in Denmark, the EDISON[33] pilot project demonstrated that EVs can function on a large scale, yielding practical lessons and technical advances. In this project, the local utility managed the distributed resource of a fleet of EVs (driven by residents on the Danish island of Bornholm) as a single virtual power plant. This program explored demand response strategies (including the impact of TOU rates) and options for charging station infrastructure. It also evaluated the utility business case for EVs.[34]

The U.S. Department of Defense (DoD) is piloting an extensive program with plug-in EVs, in cooperation with local utilities and independent system operators serving six military bases. DoD is using fleet management software as a primary interface for monitoring and managing EVs as a resource. The software dispatches charging signals from the local utility or system operator to charging stations, to optimize vehicle charging patterns. Sometimes, the EVs feed power into the grid through vehicle to grid (V2G) technology. According to DoD, V2G strategies are "an essential element to satisfy financial constraints on our fleet electrification efforts."[35]

In another project, researchers evaluated the economic potential of two utility-owned EV fleets and found that "V2G power could provide a significant revenue stream that would improve the economics of grid-connected electric-drive vehicles and further encourage their adoption. It would also improve the stability of the electrical grid." [36]

[32] Illinois residential real time pricing programs at Commonwealth Edison and Ameren, an overview by Plug In Illinois: http://www.pluginillinois.org/realtime.aspx

[33] EDISON project executive summary. Danish Energy Association, July 2013: http://www.edison-net.dk/Project%20Details/Executive%20Summary.aspx

[34] "Case study: Electric vehicles using sustainable energy and open networks -- the EDISON project." E-Business W@tch, 2009.

[35] U.S. Dept. of Defense, Plug-in Electric Vehicle Program. Overview presentation, 2013: http://sites.ieee.org/isgt/files/2013/03/Camron5C.pdf

[36] "Using fleets of electric-drive vehicles for grid support,"eby Jasna Tomic and Willett Kempton, University of Delaware. *Journal of Power Sources* vol. 168, 2007: http://www.rmi.org/Content/Files/Fleetsforgridsupport.pdf

Furthermore, this research reveals that larger overall profits were yielded when utilities could sell power from EVs back to the wholesale market when prices were high, sharing the benefits with EV owners.

THE FUTURE OF EVS IN THE U.S.

Charging station infrastructure still needs to be substantially built out in order to support U.S. consumer adoption of EVs at a scale that would enable powerful demand response. This includes public charging stations (either utility-owned, or operated through third-party partners such as ChargePoint[37]) as well as on-premise charging stations at homes and businesses. Developing more charging infrastructure is a significant investment, but it also represents a significant long-term revenue opportunity for utilities.

In Foster City, California, a ChargePoint station was installed at the headquarters of eMeter, a Siemens Business. Employees use it on a first-come, first served basis. Some employees own EVs, and eMeter also owns a Nissan Leaf EV. Having this charging station at the office is not merely an employment perk for eMeter staff; it also means more revenue for local utility Pacific Gas & Electric.

Most home-charging stations use a standard 220 circuit, just like what is needed for an electric clothes dryer or residential air conditioning unit. Third-party charging station providers typically provide their own TOU pricing to customers. Utilities commonly assist with, or at least promote, the installation of charging stations due to their revenue-generating potential. Sometimes permitting for charging stations can be a hurdle, but usually this can be easily addressed.

The Green Button[38] energy data standard allows U.S. consumers to download their energy data, including EV energy consumption. This can be used in calculator apps to help consumers understand the value of EVs and make smart decisions to save, or perhaps even make, money. In Michigan, Consumers Power[39] has such a calculator, and PEV4me[40] created one that uses Green Button data.

EVS FOR RELIABILITY: MICROGRIDS

When a home or business has solar panels, EVs, and charging stations, they can be used together to function as a microgrid. A microgrid is an electrical system that includes multiple loads and distributed energy resources – both generation and storage – that can be operated in parallel with the broader utility grid or as an electrical island. This combination of technologies can even help prevent outages by providing flexibility to quickly shift large loads in times of grid stress, and generally maintain grid balance.

The solar panels produce power during the day, storing excess production in the EV batteries, which, in turn, provide power to the home at night.

To make this reliability strategy work, there must be a safe way to disconnect the home from the grid because it would create a significant hazard to power a house from the battery while it is also connected to grid power.

In the event of an outage, control at the home's smart meter — provided automatically by demand response management software, as well as by a manual switch — could disconnect the home from the grid and activate the local microgrid. The meter would also sense when grid power is restored, deactivate the microgrid, and reconnect the home to the grid. This concept is relatively simple, but this strategy still needs to be tested through pilot projects.

[37] ChargePoint EV charging station provider: http://www.chargepoint.com
[38] Green Button energy data standard info: http://www.greenbuttondata.org
[39] Plug-In Electric Vehicle interactive calculator, by Consumers Power, Michigan: http://www.consumersenergy.com/apps/pev/index.aspx?ekfrm=3751
[40] Plug In Electric Vehicle for Me savings calculator: http://www.pev4me.com. This project was a finalist in the U.S. Dept. of Energy 751x?ekfrm=3751" gan: 2013: project.bcontest.

CONCLUSION

Though the market is still in its infancy, consumers are buying more EVs at an ever-increasing rate.

Forward-thinking utilities and regulators are already getting ahead of this trend with pilot programs and innovative rates. Smart grid technology and software allow EVs to be managed as a coherent yet flexible grid resource.

Investments in EVs and their associated infrastructure are likely to do more than just help utilities stay competitive. They are likely to yield considerable returns, while also giving consumers valuable options and peace of mind, and while addressing environmental concerns.

The best part about deploying such a flexible resource as EVs is that it can be used creatively. It is likely that even more powerful and profitable V2G strategies remain to be discovered.

ABOUT THE AUTHOR

Chris King is Global Chief Regulatory Officer for Siemens Smart Grid Services. An internationally recognized authority on energy regulation and competitive energy markets, Chris is widely recruited by regulators and legislators to consult on technology issues in electric restructuring, smart meters, and grid management. He has testified before the U.S. Congress and was instrumental in crafting the Energy Policy Act of 2005 that paved the way for advanced metering and Smart Grid initiatives in the USA. He chairs the Brussels-based Smart Energy Demand Coalition and the Silicon Valley Leadership Group Energy Committee, and is on the Executive Board of the Demand Response and Smart Grid Coalition. Chris also was one of the founders of eMeter, now a Siemens Business, focused on smart meter data management and applications.